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CRLR 109  
Project 4-12-10-002

SPECIAL REPORT

RESULTS OF CHEMICAL CORPS,  
CHEMICAL AND RADIOLOGICAL LABORATORIES  
PARTICIPATION IN OPERATION THUNDERCLOUD

by

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CHEMICAL AND RADIOLOGICAL LABORATORIES  
Army Chemical Center  
Maryland

24 November 1952

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PARTICIPATION IN OPERATION THUNDERCLOUD

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ABSTRACT

I. OBJECT

One of the objects of project 4-12-10-002 was to observe the effects on clothing and equipment of troops marched to within 500 yards of ground zero, across terrain recently exposed to an atomic blast. A further objective was the study of the shielding effects of vehicles exposed to the blast, on clothing and equipment within the vehicles.

II. CONCLUSIONS

A. No problem is presented by contamination of either impregnated or unimpregnated clothing.

B. Airborne radioactivity at 1500 yards from ground zero is higher than that specified as hazardous; see Department of the Army Pamphlet No. 8-11.

C. Filter efficiencies of Tank Collector Protectors are very high, as indicated by the negligible count above background on the cotton wads in the facepiece of the tank mask.

D. The prompt gamma radiation outside the tank and the personnel carrier, recorded as 285 roentgens, was reduced markedly by the shielding effects of these vehicles. The Medium Tank, M-26, and its earth emplacement, effected a reduction of more than 99% in the driver's seat, and 94% in the loader's seat. Shielding by the Personnel Carrier, T18E1, reduced this radiation by 95% or more.

III. RECOMMENDATIONS

None are presented, since the Chemical Corps AW tests on material are continuing.

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ATOMIC ENERGY ACT - 1946

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION . . . . .	1
II. TEST METHODS AND RESULTS . . . . .	1
A. Evaluation of Chemical Corps Protective Clothing . . . . .	1
B. Shielding Afforded by Medium Tank, M-26 . . . . .	2
1. Preparation . . . . .	2
2. Evaluation of Shielding and Protection Afforded by Medium Tank, M-26 . . . . .	3
C. Activity Determinations Inside Personnel Carrier, T18E1 . . . . .	6
1. Contamination of Chemical Corps Protective Clothing . . . . .	6
2. Dust Contamination Inside Personnel Carrier . . . . .	6
3. Shielding From Prompt Gamma Radiation . . . . .	7
III. CONCLUSIONS . . . . .	7
IV. RECOMMENDATIONS . . . . .	8
APPENDIX A . . . . .	9
APPENDIX B . . . . .	11
APPENDIX C . . . . .	12
APPENDIX D . . . . .	13

ILLUSTRATION

Figure I . . . . .	4
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RESULTS OF CHEMICAL CORPS CHEMICAL AND RADIOLOGICAL  
LABORATORIES PARTICIPATION IN OPERATION THUNDERCLOUD

I. INTRODUCTION

A. Object

One of the objectives of project 4-12-10-002 was to observe the effects on clothing and equipment of troops marched to within 500 yards of ground zero, across terrain recently exposed to an atomic blast. A further objective was the study of the shielding effects of vehicles exposed to the blast, on clothing and equipment within the vehicles.

B. Authority

Authority for this work was contained in RDB Project 4-12-10-002, "Apparatus and Methods for Atomic Weapons Test, Operation WINDSTORM," approved 11 January, 1951.

II. TEST METHODS AND RESULTS

A. Evaluation of Chemical Corps Protective Clothing

The purpose of this portion of the test was to determine the radiological contamination picked up by military personnel wearing XX-CC-3 impregnated clothing, while walking through a contaminated area shortly after an aerial nuclear detonation.

Ten men walked 2 miles toward ground zero, stopping 500 yards from ground zero. From this point they moved back by a slightly different route to a position 1300 yards from ground zero, where fatigues, shoes, and steel helmets were monitored. This monitoring took place at H + 4 hours, and required approximately 45 seconds per man.

For approximately the first  $1\frac{1}{2}$  miles (to 900 yards from ground zero) the dose rate was between 0.03 and 0.05 mr/hr. At 600 yards from ground zero the dose rate increased abruptly, reaching 90-100 mr/hr (at H + 3 hours). At 500 yards from ground zero intensity of radiation reached 390-400 mr/hr (H + 3.1 hours); at 1300 yards from ground zero, on return trip to camp, background was 1.3 mr/hr.

Five of the ten men wore cotton-sateen coveralls, and five wore heringbone twill coveralls. In each group of five, four garments were impregnated and one was unimpregnated. The men wearing impregnated coveralls wore the following impregnated undergarments:

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- a. Drawers, cotton, white, protective.
- b. Shirts, cotton, white, protective.
- c. Socks, woolen, white, protective.
- d. Gloves, cotton, white, protective.

The two control personnel wore similar unimpregnated underclothing. All test personnel wore helmet liners and combat boots-eight impregnated and two unimpregnated. Outer garments were first monitored at a point approximately 1300 yards from ground zero, and all test clothing was monitored on the return to Camp Desert Rock.

Monitoring tests indicated that in general contamination did not exceed background. The only exception to this finding was on shoes, on which contamination did not exceed 2 or 3 times background (see Appendix B).

B. Shielding Afforded by Medium Tank, M-26

1. Preparation

A Medium Tank, M-26, was emplaced at a depth of 3 feet at a position 1500 yards upwind from ground zero, the tank itself facing away from the blast, and the gun turned toward the blast (see Appendix D, Fig.D1). Hatches were closed and the engine was turned off during the test, to reduce as far as possible the amount of radioactive dust entering the tank before and after the detonation.

Five coveralls were placed inside the tank, as follows:

a. One unimpregnated and two impregnated HBT's in the loader's seat, the gunner's seat, and the commander's seat, respectively, in the turret compartment (see Appendix D, Fig.D3).

b. One unimpregnated and one impregnated cotton-sateen in the driver's and assistant driver's seats, respectively.

To further appraise the protection afforded by the tank against radiation hazards, three filter units were used to measure the weight and radioactivity of dust, within and outside the tank, resulting from the aerial detonation. One filter unit was mounted on the tank fender nearest ground zero, and two filter units were placed inside the tank, one in the driver's compartment and one in the turret compartment. These units were operated at a flow rate of 3.75 cfm from H - 10 minutes until approximately H + 1 hour, at which time the motors were stopped, and the filters collected. The cloud of dust was estimated to be in the vicinity of the tank for about 45 minutes.

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An evaluation of the efficiency of the Tank Collective-Protector, E-26, was also made at this time. Prior to the atomic detonation, two such collective-protectors supplying purified air to individual facepieces were installed in the tank, and were later operated during the same period as that employed for the filter units. Small cotton wads were emplaced between the canister and the facepiece to collect those particles which would have passed through the filter and entered the lungs of a man wearing the facepiece, had he been in the tank during the test period.

2. Evaluation of Shielding and Protection Afforded by Medium Tank, M-26

Clothing was recovered from the tank one hour after the nuclear detonation. Monitoring of each coverall shortly thereafter showed conclusively that the clothing was practically uncontaminated with radioactive dust. The maximum reading obtained with a Model PR-3 Survey Meter was 0.04 mr/hr at 6 inches, using a side window G-M tube probe. Background was 0.03 mr/hr.

Figure 1 shows the three sheets of Chemical Corps Filter Material, Type 6, carrying the dust collected during the test period. A tear is apparent in the filter which operated outside the tank. It is believed that the pressure wave from the detonation was responsible for this breakage. Test data were probably valid, however, because the actual filter material was backed up by two thicknesses of Chemical Corps Poly-Fiber paper, which were unbroken.

Weighing the dust collected on these sheets during a 1-hour sampling period, provided the following data:

Location	Wt. of Dust (gms)	Av. Conc. of Dust in Air (mg/liter)
Outside M-26 Tank	0.418	0.0874
Driver's Compartment	0.176	0.0369
Turret Compartment	0.340	0.0711

The radioactivity of the dust collected on the three filters from known sample volumes of air was determined shortly after collection of the samples, by the National Institute of Health. Determination of activity was calculated as of H + 1 hour:

Location	Measured Activity (microcuries)	Av. Conc. of Radioactivity in Air ( $\mu$ c/liter)
Outside M-26 Tank	0.26	$5.4 \times 10^{-5}$
Driver's Compartment	0.10	$1.2 \times 10^{-5}$
Turret Compartment	0.13	$1.9 \times 10^{-5}$

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Fig. 1 Contaminated Dust Samples on Type 6 Filter Paper, Dog Shot, Operation BUSTER

The maximum permissible concentration of fission products in air, for personnel without protective masks, is  $10^{-6}$  microcuries per liter. The general rule is to wear protective masks when this concentration is reached, and to evacuate the area when the concentration reaches  $10^{-5}$  microcuries per liter.<sup>1</sup>

The specific activity of the airborne dust was found to vary from  $10^{-4}$  to  $10^{-5}$  millicuries per gram. Activity readings taken between 14 and 36 hours after detonation indicate radioactive nuclides with an average half-life of 41 hours (see Appendix C). Absorption curves indicate that these nuclides have an average beta energy of 1.8 Mev.

The cotton wads used to collect the particulate matter passing through the collective-protector filters were monitored 48 hours after the detonation by the National Institute of Health. These radiometric analyses are given below:

TCP Compartment No.	Face-piece No.	Activity (c/m at H + 48 hrs.)			Calc. Activity (Net c/m at H+48 hrs.)
		Total Count	Background	Net Count	
1 Driver's	1	24.3	22.3	2.0	4.0
1 Driver's	2	22.2	22.2	0.0	0.0
2 Turret	1	23.2	22.3	0.9	1.8
2 Turret	2	23.3	22.3	1.0	2.0
2 Turret	3	26.6	22.3	4.3	8.6

The beta-gamma radiation from fission products collected in the TCP's was measured with a survey meter. Even when the "net count" shown above is doubled (because the filtration efficiency of the cotton wads was estimated at 50%), the hazard was found to be negligible.

The M-26 Tank provided considerable shielding from prompt gamma radiation as well as from radioactive aerosols. Dosages inside the tank varied considerably, probably due to differences in steel thickness ( $\frac{1}{2}$  inch to 4 inches), and to attenuation of emplacement earth. At the site of emplaced tanks, prompt gamma radiation was measured as 230 roentgens and as 340 roentgens by two separate individuals. As determined by film badge dosimeters, prompt gamma radiation inside the tank was as shown below:

1. Handbook of Atomic Weapons for Medical Officers, Dept. of Army Pamphlet No. 8-11, p. 50, June 1951.

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Location	Dosimeter Film Type	Dosage (roentgens)
Loader's Seat	DuPont No. 552	11.0
Commander's Seat	DuPont No. 552	6.3
Driver's Seat	DuPont No. 552	2.2
Driver's Back	DuPont No. 552	2.6
Ass't Driver's Back	DuPont No. 552	2.6
Gunner's Seat	DuPont No. 552	11.0
Gunner's Seat	DuPont No. 554	18.0

C. Activity Determinations Inside Personnel Carrier, T18E1

A new type of personnel carrier, T18E1, was positioned approximately 1500 yards south of ground zero, slightly east of the Medium Tank, M-26, facing the detonation site. Data similar to those obtained within the tank were sought inside this personnel carrier. (Appendix D, Fig. D-2).

1. Contamination of Chemical Corps Impregnated Protective Clothing

Three HBT coveralls were located inside the personnel carrier, as follows:

- a. One impregnated suit in the driver's seat (driver's hatch closed).
- b. One unimpregnated suit in the commander's seat (commander's hatch open).
- c. One impregnated suit in one of the west seats.

This clothing was recovered from the personnel carrier at H + 1 hour, and monitored. Activity readings showed that the clothing was essentially uncontaminated with radioactive dust. Maximum readings obtainable with a PR-3 survey meter using a side window G-M tube probe at 6 inches, was 0.03 mr/hr, the same as background.

2. Dust Contamination Inside Personnel Carrier

The same technique as that employed inside the tank was used for the measurement of concentration and activity of dust particles in the air inside the personnel carrier. One filter unit was mounted on the middle seat in the troop compartment, and was operated at a flow rate of 3.75 cfm from H - 10 minutes until H + 1 hour. The data obtained from this air sampling period, with Chemical Corps Type 6 filter material as the collecting surface, Fig. D-1, are shown below:

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Wt. of Dust (grams)	Av. Conc. of Dust in Air (mg/liter)	Activity (microcuries)	Activity Conc. in Air ( $\mu\text{c/liter}$ )
0.649	0.1357	0.18	$3.8 \times 10^{-5}$

### 3. Shielding From Prompt Gamma Radiation

The intensity of prompt gamma radiation outside the personnel carrier was 285 roentgens. Film badge dosimeters were placed on each of the seats designated for personnel. Dosages, as indicated by these badges, are shown below:

Seat	Location	Film Type	Activity (roentgens)		
			1	2	Average
1	Right Row	DuPont 552	14	15	14.5
2	Right Row	DuPont 552	14	15	14.5
3	Right Row	DuPont 552	14	--	14.0
1	Center Row	DuPont 552	15	14	14.5
2	Center Row	DuPont 552	15	14	14.5
3	Center Row	DuPont 552	14	burned	14.0
1	Left Row	DuPont 552	12	14	13.0
2	Left Row	DuPont 552	13	15	14.0
3	Left Row	DuPont 552	15	14	14.5
4	Left Row	DuPont 552	14	14	14.0
5	Left Row	DuPont 552	14	15	14.5
2	Center Row (Head Level)	DuPont 554	42	--	42*
-	Commander's Head	Polaroid	40	--	40*

\* These badges were situated in the line of sight through commander's open hatch to point of bomb detonation.

### III. CONCLUSIONS

On the basis of the tests run, the following conclusions were drawn:

#### A. Contamination of Chemical Corps Protective Clothing

No problem is presented by contamination of either impregnated or unimpregnated clothing.

#### B. Respiratory Hazard from Radioactive Dust

Airborne radioactivity at 1500 yards from ground zero is higher than

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that specified as hazardous; see Department of the Army Pamphlet No. 8-11.

C. Filter Efficiencies of Tank Collective-Protectors

Filter efficiencies of TCP's are very high, as indicated by the negligible count above background on the cotton wads in the facepiece of the tank masks.

D. Shielding from Prompt Gamma Radiation

The prompt gamma radiation outside the tank and the personnel carrier, recorded as 285 roentgens, was reduced markedly by the shielding effects of these vehicles. The Medium Tank, M-26, and its earth emplacement, effected a reduction of more than 99% in the driver's seat, and 94% in the loader's seat. Shielding by the Personnel Carrier, T18E1, reduced this radiation by 95% or more.

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## APPENDIX A

### Monitoring Points for Protective Items

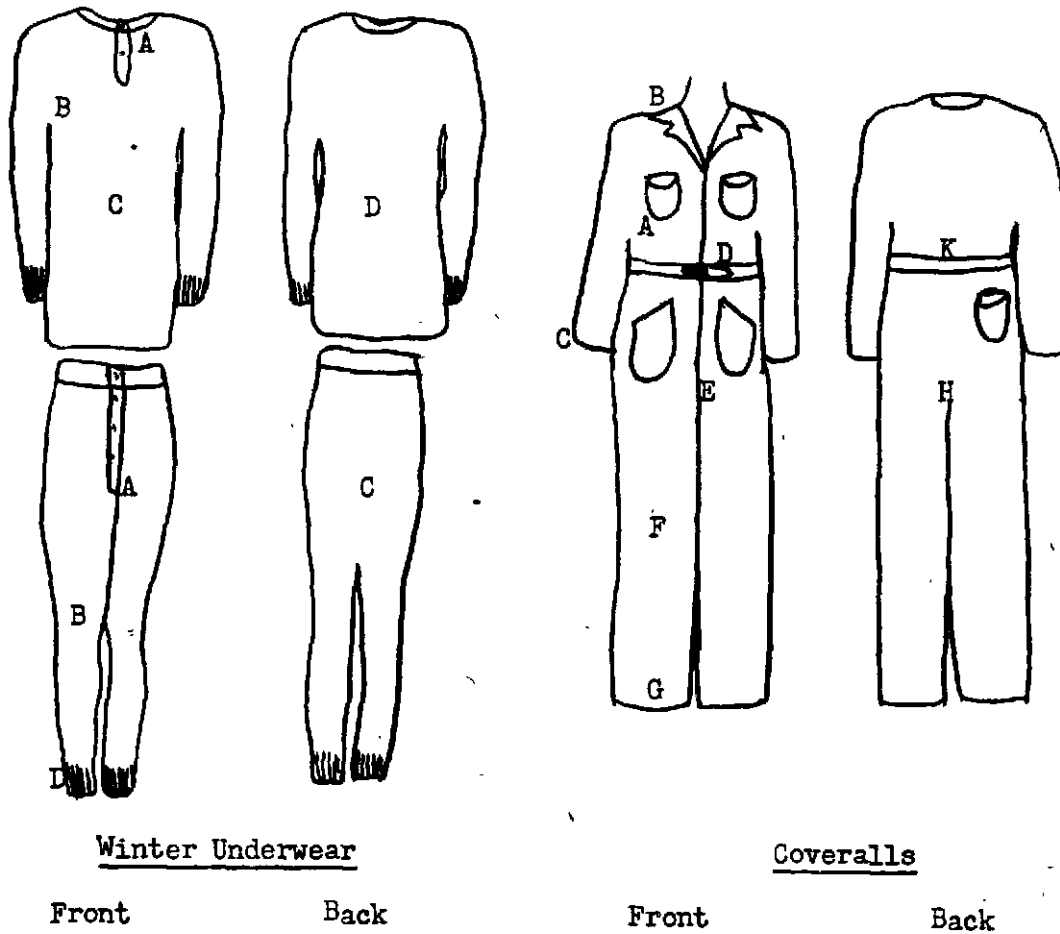


Figure A.1 Monitoring Points for Clothing

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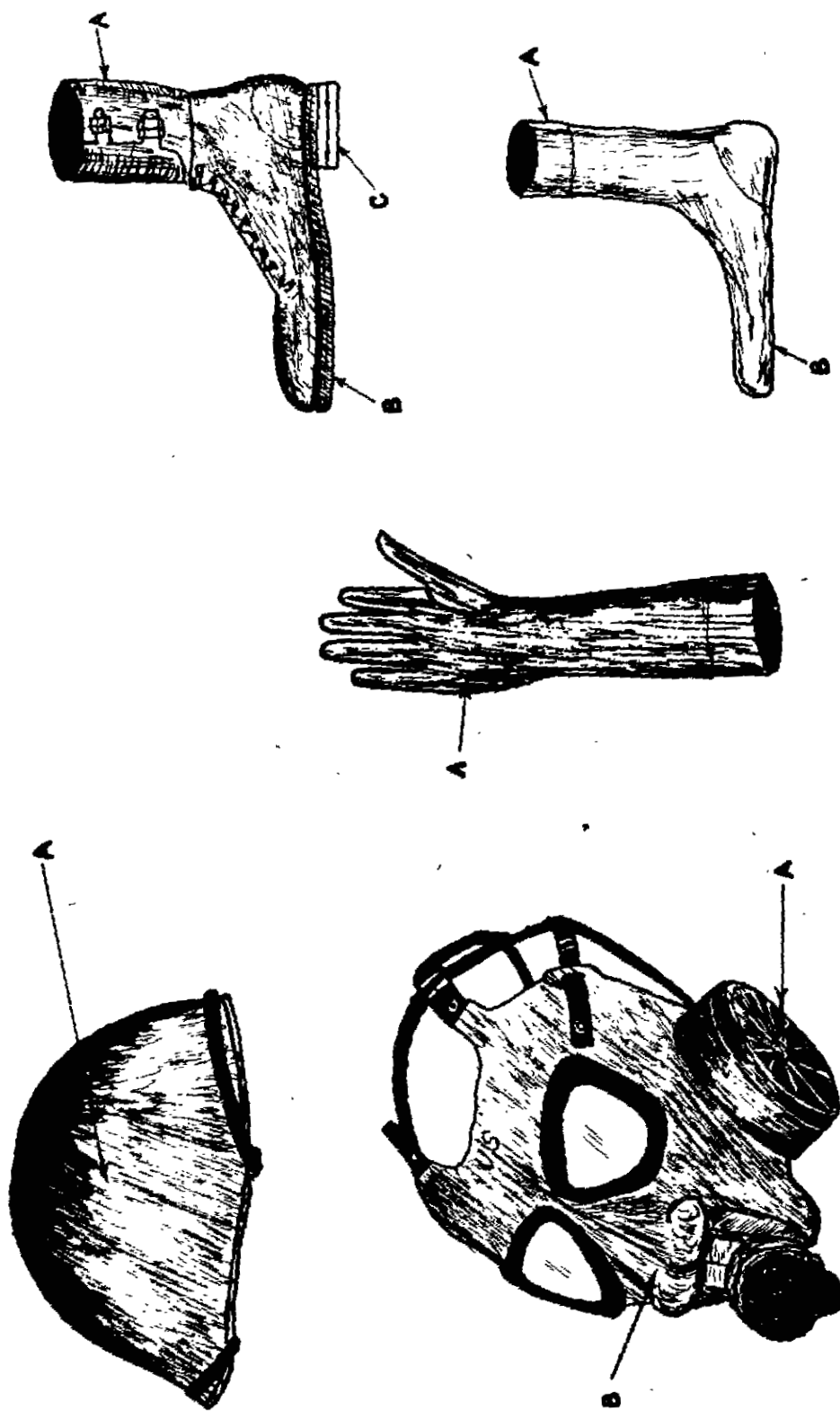


Fig. A-2 Monitoring Points for Helmet, Mask, Glove, Boot & Sock

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APPENDIX B

Contamination on Clothing in Operation THUNDERCLOUD

Table 1

Contamination of Clothing Worn by Men Walking

Clothing Item	Dosage Rate (mr/hr)				
	Man No.	Man No.			
	1*	2	3	4	5**
Cotton Sateen Coverall	0.01	0.01	0.00	0.02	0.01
Cotton Gloves	0.00	0.01	0.03	0.03	0.01
Undershirt, Winter	0.00	0.01	0.00	0.00	0.00
Underdrawers, Winter	0.00	0.00	0.00	0.00	0.00
Cotton Socks	0.00	0.00	0.01	0.01	0.01
Boots	0.05	0.04	0.04	0.05	0.05
Helmets	0.04	0.04	0.04	0.05	0.04
Gas Masks, M9A1	0.01	0.01	0.02	0.02	0.02

\* This man wore unimpregnated clothing.

\*\* These four men wore impregnated clothing.

Table 2

Contamination of Coveralls in Stationary, Unmanned, Armored Vehicles

Fabric	Location	Vehicle	Average Reading (mr/hr) *	
			Unimpregnated Clothing	Impregnated Clothing
Cotton - Sateen	Driver's Comp't	M-26 Tank	0.00	0.01
Herringbone Twill	Turret Comp't	M-26 Tank	0.00	0.00
Herringbone Twill	Personnel Comp't	T18E1 Carrier	0.00	0.00
Herringbone Twill	Driver's Seat	T18E1 Carrier	-	0.00

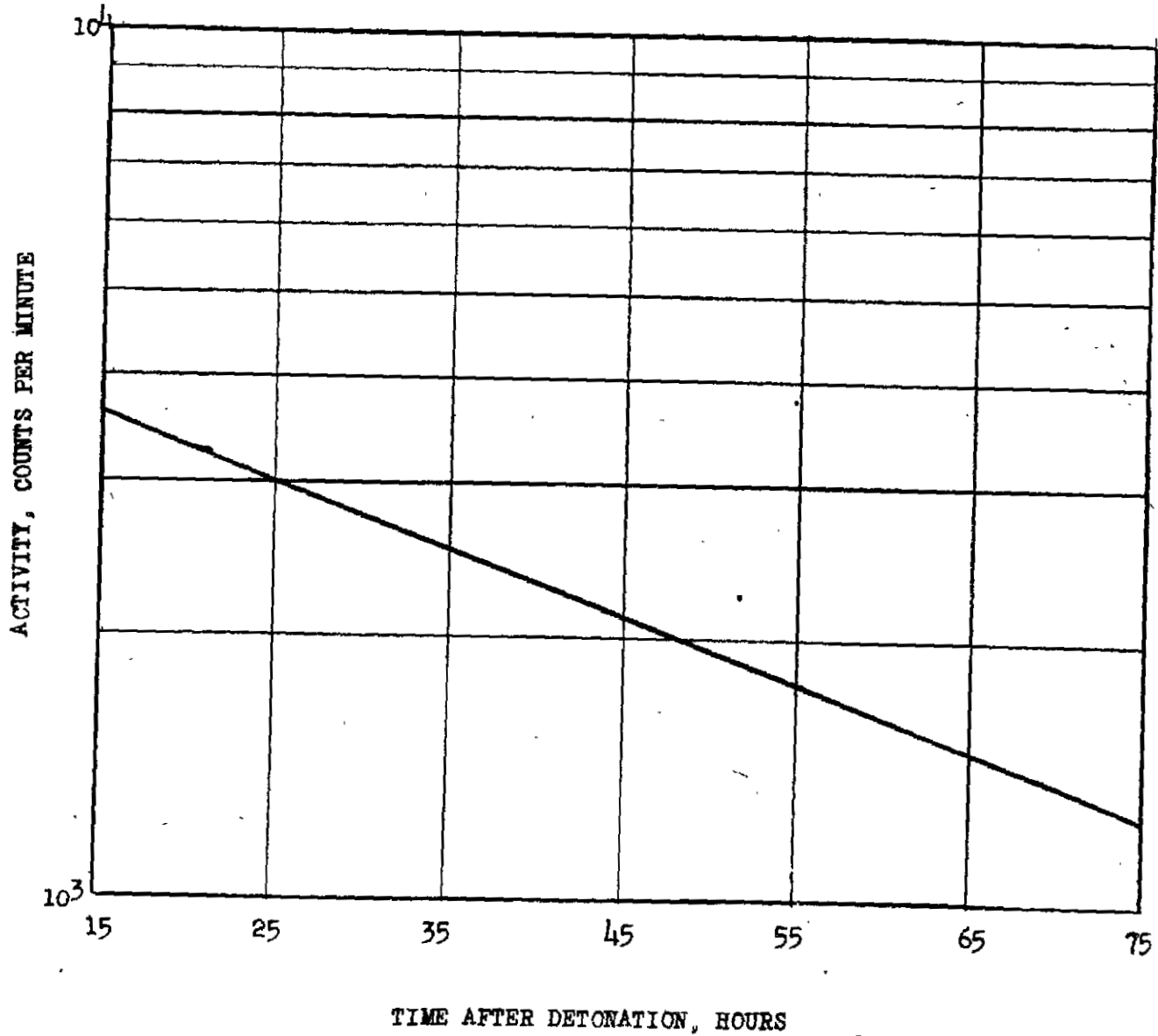
\*Readings taken at H + 5 hours with PR-3 Survey Meters at distance of 6 inches.



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APPENDIX C

Decay Curve of Radioactive Dust in Air  
in Operation THUNDERCLOUD



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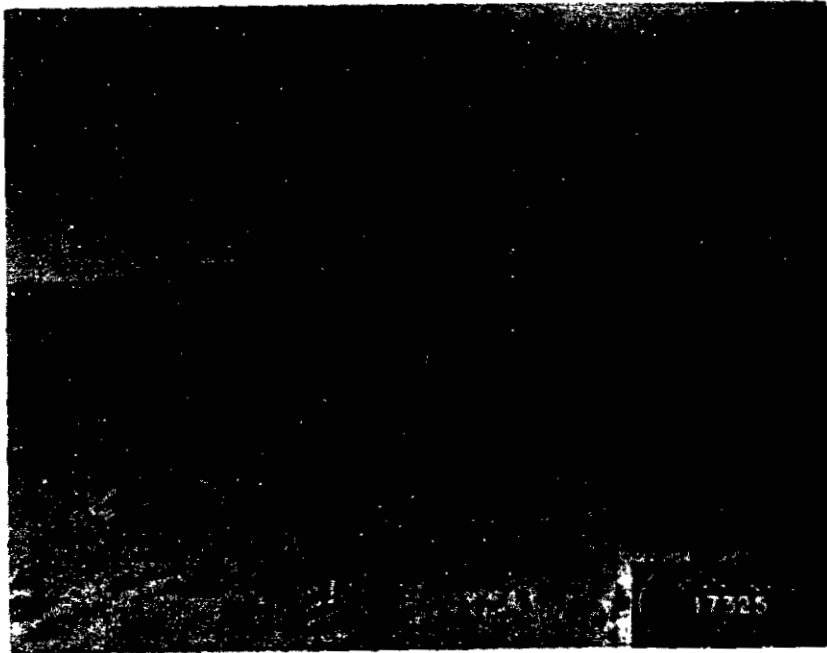


Fig. D-1 Tank, Medium, M-26, Emplaced 1500 Yards from Ground Zero (Gun Facing Toward the Blast)

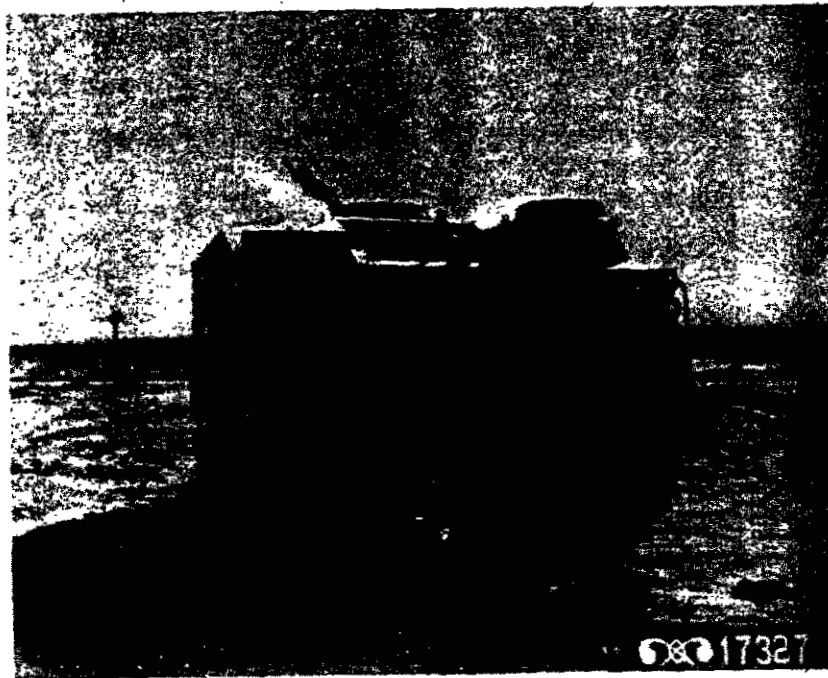


Fig. D-2 Personnel Carrier, T18E1

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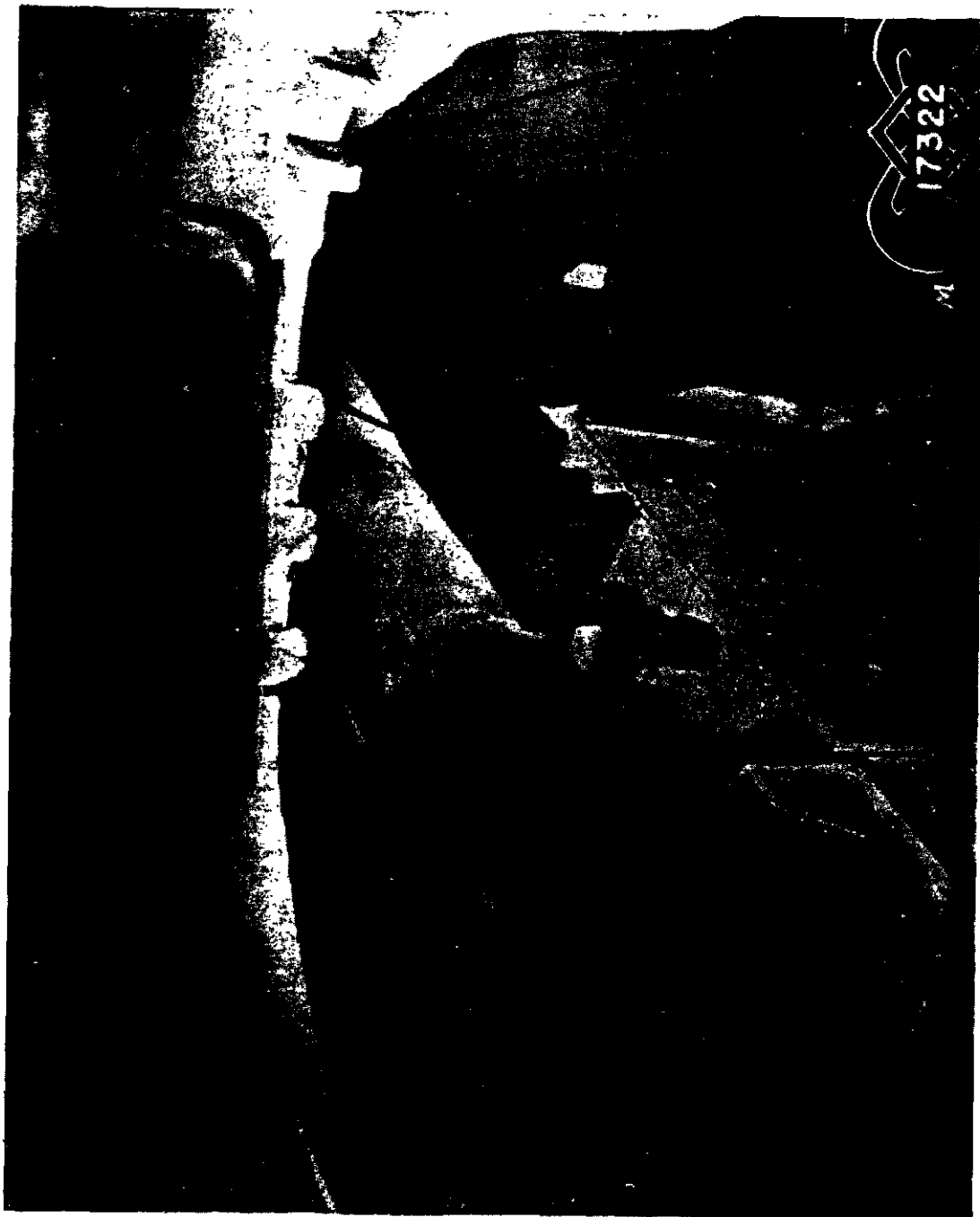


Fig. D-3 Inside Turret Compartment in M-26 Tank; Showing Tank Collective Protector, Film Badges, and Protective Clothing

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